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A STATUS REPORT ON MEDICAL LASER TECHNOLOGY

Michael Moretti, *Medical Laser Insight,* Mission Viejo, CA

Medical laser technology has evolved from primarily surgical applications 10 years ago, to a strong focus on aesthetic "elective" procedures at the present time. This presentation will cover the major lasers of interest; commercial status of each technology; and the manufacturers producing these lasers. I will also discuss the market dynamics driving commercialization of these technologies.

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POINT-AND-COUNTERPOINT: SHOULD NURSES AND OTHER TRAINED ALLIED HEALTH PROFESSIONALS BE ALLOWED TO PERFORM LASER SURGERY?

Deborah S. Sarnoff, Greenvale, NY

Laser surgery is surgery - best performed by those licensed to practice medicine and surgery. Should laser surgery, utilizing a Class IV device, be performed by anyone other than a licensed physician? Can a nonphysician assess the signs and symptoms of a patient and arrive at the proper diagnosis? Does a nonphysician have the educational background and training to assess the clinical problem and choose the preferred wavelength and laser parameters? Is a nonphysician equipped to respond to emergencies, if one should arise? When a complication develops after laser surgery, can a nonphysician diagnose the problem and prescribe the proper treatment?

These issues will be fully explored and participants will be reminded that laser surgery is not a simple "point-and-shoot" matter.

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WHAT'S NEW WITH LASERS IN UROLOGY

Steven H. Selman, Medical College of Ohio, Toledo, OH

Over the last 20 years, medical lasers have become an integral part of urologic care. The incorporation of lasers into the practice of urology has been evolutionary, continuing to the present day. Miniaturization of endoscopics and advances in both intracorporeal and extracorporeal medical imaging technologies have facilitated the clinical growth of urologic laser use.

What then is "new" in lasers in urology in 1998. Although not new, the Holmium YAG laser continues to generate enthusiasm in the urologic community as a cost effective multipurpose laser. The capacity of this laser to ablate, coagulate, and incise soft tissue as well as fragment calculi has considerable appeal in these times of cost containment.

The use of lasers in the treatment of both benign and malignant disease of the prostate continues to generate both experimental and clinical interest. The efficacy of thermal lasers for photocoagulation in the treatment of benign prostatic hypertrophy has been established. The technique to accomplish this end, however, continues to evolve. Thus, both transurethral and interstitial photocoagulation of prostatic tissue have their proponents. There is growing interest in the use of the Holmium:Yag laser to perform a resection of prostatic tissue similar to the classic electrosurgical transurethral resection. Other groups have been exploring the use of photodynamic therapy (PDT) for the treatment of both benign and malignant disease of the prostate.

Other major areas of investigation and evaluation are tissue welding and diagnostic tissue spectroscopy.

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WHAT'S NEW WITH LASERS IN AUSTRALIA?

Sue McCoy MD.

Australia in size is only slightly smaller that the USA yet the population at around 18.5 million remains equivalent to about two thirds that of California. Nonetheless, in a few underfunded little laboratories and quiet corners of University Hospitals a handful of researchers and physicians are making a contribution to laser Science and Medicine. Perhaps the most notable is in the field of Photodynamic Therapy for cerebral gliomas and mesotheliomas.

Most privately practising laser physicians and surgeons in Australia simply see their laser(s) as another addition to the range of technologies available with which to ply their trade, but a few have kept records of their work and have used the Literature to share with other medical colleagues their experiences, both good and bad! Although accurate statistics are not available Australia may well have one of the highest doctor-laser ratios in the world. We are renown for our technophilia.

In addition, several medical lasers are manufactured in Australia including NdYAGs for ophthalmic purposes, copper bromides for dermatology and low level units for analgesic, antiinflammatory and physical therapy uses.

A brief tour of Australia's main population centers will show what is being done where with lasers in Medicine and Surgery in this country.

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"WHAT'S NEW IN AESTHETIC LASER SURGERY IN FRANCE"

BENJAMIN ASCHER – Plastic Surgeon – PARIS - FRANCE

In 1998, aesthetic laser surgery French development quite well represents the European development. They both follow two main guidelines:
-30% of the dermatologists, plastic surgeons, and aesthetic GP population frequently uses lasers; however, only 3% owns partially or totally the machines.
-whereas a non European patient quite easily accepts longlasting redness after laser treatment, a French patient does not adopt this attitude at all. This is why the recent pulsed CO2 and ERBIUM-YAG lasers are bringing out new interest.

The most used cutaneous lasers in France are:

- FOR PIGMENTED LESIONS:

QS lasers (yag, rubis, alexandrite), especially for superficial lesions.

- FOR VASCULAR LESIONS:

Pulsed colored lasers are more employed than the French HEXASCAN Argon.

- FOR HAIR REMOVAL:

* The ND YAG 1064 is judged unsatisfactory;
* The Rubis laser continues to be used even if the number of its passes needs to be high;
* The Alexandrite, recently introduced, seems to be promissing.

- FOR TREATING THOSE THREE KINDS OF LESIONS:

Pulsed light, introduced 18 months ago, is an efficient and safe method.

- FOR RESURFACING

New CO2 pulsed lasers, since 1995, and ERBIUM-YAG lasers, since 1996, better match the patient needs: a stable result with only 2 or 3 weeks redness follow-up.

- FOR BLEPHAROPLASTY:

Laser assisted blepharoplasty, since 1984, is underdeveloped because of the

facts that:
* Few surgeons are laser's owners;
* Coagulation microneedle quite well reemplaces the laser in section-coagulation technique with less cost for the surgeon.
However, new lasers combining within the same machine.
- CO2 section mode
- CO2 and/or ERBIUM YAG resurfacing mode (DENMARK) will allow physicians to optimize their involvement and their result.

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WHAT SHOULD BE THE ROLE OF INDUSTRY IN SUPPORTING CLINICAL RESEARCH, AND HOW CAN OUTCOMES BE MONITORED?
R. Rox Anderson, MD, Harvard Medical School, Boston, MA

Ideally, clinical research should be well-controlled, answer significant questions, analyze and report without bias, regardless of the outcome. Four "strange bedfellows" are necessary to bring new laser procedures into medicine - academia, industry, government, and clinical practitioners. Ideally, all four aim for the safest, most effective and cost-effective care. NIH support via SBIR grants, the central role of technology, and FDA regulations, put industry in a pivotal position to both support and influence clinical research. Industry-sponsored research is inherently linked to the profit motive, and subject to 1. biased study designs, 2. reporting "positive" but not "negative" results, and 3. cutting corners. The other three bedfellows - academics, FDA, and practicing physicians - *should therefore be congenitally suspicious of industry-sponsored studies, forever.* The best companies understand this, and even encourage critical inquiry. The same suspicion should extend to any investigator with a profit motive. Research and ethical standards vary among companies from essentially none to superb. Telling the difference takes some effort and thought. When shown a few cases in which light source A is better than laser B – ask for a complete copy of the research protocol and results. Was this a side-by-side comparison covering the full range of fluences for each device, such that benefit/risk can be assessed? Were these *prospective, consecutive* patients? What quantitative, unbiased measures were used for endpoints? Does the data actually justify the claims? Who did the study and how much stock do they own? Is the company dogmatic or zealous? FDA "approves" nothing, and only "clears" devices for marketing – so FDA clearance is not a stamp of approval. No matter which of the bedfellows you represent, the final question to ask is: "Would I comfortably choose this treatment for myself or my loved ones?" Clinical scientific bias and self-deception can be insidious. For example, see The Mismeasure of Man, Stephen J. Gould. Unless, you prefer to believe that Englishmen actually do have larger brain cases....

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LASERS: TOOLS OR PROCEDURES?
RJ Lanzafame, Rochester General Hospital Laser Center, Rochester, NY

The treatment and alteration of disease are primary goals of medical care. The clinician will select a therapeutic pathway from a group of options based on experience, judgment, skill, and perceived "need". Lasers are most often utilized as a tool based on their "intended use" in order to affect a part of a procedure or process. This use may account for a small portion of the so-called "laser surgery". The indication for the procedure is the diagnosis or symptoms and the procedure is most often one of a number of standard options with the exception that a laser device is being used for a portion of the case. For most situations, lasers are utilized as tools rather than treatments or procedures. Laparoscopic cholecystectomy with lasers is an excellent example of this. The laser device (one of several selected by the surgeon) is used to separate the gallbladder from its attachment to the gallbladder bed. The majority of this procedure is accomplished with a wide array of non-laser devices. The indication for the procedure is symptomatic cholecystitis and cholelithiasis and the treatment is cholecystectomy, which in our example, was performed via laparoscopy with the use of a laser. The treatment could have been conducted via other approaches and each of these approaches may be acceptable for the management of a particular patient. Other situations exist wherein a laser device may be considered to be a treatment. Low level laser therapy applications represent one such case. In these examples, the laser is used as the sole treatment or in combination with other adjuncts, such as local wound care or non-steroidal anti-inflammatory drugs.
Both clinicians and the public continue to equate any new, high tech or minimally invasive process with lasers. This session examines the use of lasers in clinical practice and will provide a framework to classify the use of these devices as tools, treatments or unique procedures.

TISSUE WELDING

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DYE-ASSISTED LASER SKIN WELDING WITH PULSED RADIATION: *IN VIVO* WOUND HEALING RESULTS.

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Laser welding was explored as a potential alternative to sutures for the closure of skin wounds.

Continuous-wave 1.06-μm Nd:YAG laser radiation was scanned over 2 cm-long incisions made on the backs of guinea pigs. India ink was applied to the wound edges prior to welding to enhance radiation absorption at the weld site. A mechanical clamping system was used to temporarily appose wound edges with minimum pressure during welding. Neither sutures nor biological adhesives were added to the weld site. Laser radiation was scanned over the weld in 80 millisecond pulses with 8 seconds of cooling between scans. Incisions were also closed using sutures on each animal and tested as controls. Laser power and spot size were kept constant at 10 watts and 4 mm, respectively. The operation time was also fixed at 10 minutes per a weld.

The welds remained closed post-operatively under considerable stress. The animals were able to perform all normal functions upon completion of surgery. Immediate tensile strengths of welds (~1.8 kg/cm^2) were greater than tissue apposition strengths (~0.4 kg/cm^2) using 3 sutures. Weld strengths continued to increase during the wound healing process, which was studied at 0, 3, 6, 10, 14, 21, and 28 days. Although the India ink tattooed the skin, it did not produce a severe foreign body response, and normal wound healing was allowed to progress.

Dye-assisted pulsed welding of skin represents a promising method of tissue closure. Potential advantages over sutures include increased immediate tensile strengths of wounds, fluid-tight closure, and less mechanical damage to tissue. Wound healing is comparable to that of sutures. With improved technique, laser welding may also provide faster operative repair of skin than sutures.

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VASCULAR ANASTOMOSIS BY LASER WELDING USING HUMAN ALBUMIN SOLDER

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New techniques for vascular anastomosis which may improve minimally invasive direct-coronary artery bypass surgery (MID-CAB) are being developed that are more reliable and can be performed in less time through smaller incisions. Common carotids in a canine model were transected and an end-to-end anastomosis was performed using one of four techniques (1) continuous 6-0 polypropylene closure (suture, n=6), (2) vascular clip (VCS, n=6), laser welding using 50% albumin solder with (3) 1.32 micron laser (1.32las, n=6) and (4) 1.9 micron diode laser (1.9las, n=4). Time for anastomosis (TA) was compared between groups by t-test. Baseline systemic pressure (BSP) across anastomosis and pressure at which anastomosis failed (leak point pressure, LPP) were determined and compared by ANOVA. TA was faster for 1.32las and 1.9las, 8.4±0.7 and 7.8±0.3 min. respectively, when compared to suture, 13.8±1.0 min. (p=0.001). There was no difference between VCS, 8.3±3.3 min. and any other group (p>0.17).

	1.32las	1.9las	Suture	VCS	p
BSP(mm Hg)	130±5	120±5	120±6	140±7	0.25
LPP(mm Hg)	350±40	280±30	350±50	360±50	0.68

Laser welding using 50% human albumin solder resulted in faster anastomotic times. Anastomoses were equivalent to conventional sutured anastomoses, failing at similar pressures and withstanding pulsatile flow at systemic pressure. Laser welding using human albumin solder may be advantageous in improving coronary anastomoses in MID-CAB, but long-term anastomotic strength and histologic evaluation need to be done.

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LASER ASSISTED TISSUE SOLDERING: PREMIXED VS. SEPARATE DYE-SOLDER METHOD

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Abstract

Laser soldering of bovine aorta has been performed *in vitro* with a technique that increases light absorption at the solder-tissue interface. A volume of 0.5 µL Indocyanine Green (ICG) solution (10 mg/mL) was deposited around a well approximated aorta incision. A 2 µL droplet of the solder (25% human albumin and 0.5% sodium hyaluronate) was put over the ICG solution and then irradiated by a diode laser at 808 nm. Laser irradiance was 12 W/cm^2 with a spot diameter of 1.5 mm. Since the laser light was primarily absorbed by the ICG dye, this thin layer of ICG solution was the heat source to the solder and the aorta lumen. By heat conduction, the solder formed a coagulum that fused onto the aorta surface. Solder tensile strength was measured after the welded specimens were hydrated in buffered saline for a designated period. The hydration periods were acute, 1 day and 1 week. The results were compared with specimens repaired using exactly the same technique, except that ICG dye was premixed into the solder (2.5 mg of ICG per 1 mL of solder) instead of separate layers of dye and solder. The hydration periods for the premixed dye-solder group were acute and 1 day. Although no statistical difference in tensile strength, scanning electron microscopy analysis suggested that the ICG layer concentrated at the solder-tissue interface provided a more reliable solder-tissue fusion than coagulating the solder with premixed ICG.

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SOLDER SOLUBILITY AND TENSILE STRENGTH VERSUS PROTEIN CONCENTRATION.

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A laser activated solid solder was coupled with a diode laser (λ= 810 nm), to investigate the dependence of the solder protein concentration on: 1) The tensile strength of the soldered tissues 2) The solder solubility prior to laser irradiation. The uncertainty of laser welding, due to the fluid glue, was overcome using the solid solder. Sixty-two severed rat tibial nerves and vas deferens were repaired using rectangular protein bands with two different Albumin concentrations (58% and 70% by weigh). The laser power (90 mW and 140 mW), dose (12.9 ± 0.7 J/mg, mean ± s.d.) and solder dimensions (thickness = 0.15 ± 0.01 mm, surface area = 7.8 ± 0.4 mm^2) were kept constant during the operations. The solder solubility at 58% and 70% BSA concentrations was investigated prior to laser radiation using the Bradford Protein Assay. Rectangular bands of solder (weight 1.2 ± 0.2 mg, band thickness 0.2 ± 0.02 mm) were immersed in 0.5 ml of saline solution for fixed intervals of times. The solder solution samples were scanned by a spectrophotometer at λ = 495 nm to measure the BSA concentrations. The laser welds with high protein solder concentration were significantly ($p<0.05$) stronger (28 ± 3.5 g) than the welds with low protein solder concentration (23 ± 5 g). The protein assay showed the solder bands with 58% BSA concentration dissolved > 50% in 60 s and the 70% BSA bands dissolved ~ 15% in 300 s. In both cases the mechanical properties of the solder (rigidity and shape) significantly deteriorated after 90 s. The solubility and average tensile strength of the laser soldered tissues increased as the protein solder concentration increased. A new solid solder has been recently developed with 75% BSA content. The solder dissolves ~ 4% in 50 min and the tensile strength is comparable to the 70% BSA solder.

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OPTIMAL SOLDER AND POWER DENSITY FOR DIODE LASER TISSUE SOLDERING (LTS).

Ian P. Schwartz, Donald D. Suh, Douglas A. Canning, Howard M. Snyder, Stephen A. Zderic, Andrew J. Kirsch. Division of Pediatric Urology, The Children's Hospital of Philadelphia, Philadelphia, Pennsylvania.

Purpose: The purpose of the study was to determine the optimal indocyanine green dye (ICG) concentration and laser power density (PD) for tissue soldering using a 808-nm diode laser.

Methods: Temperature profiles in vitro and in vivo were obtained using the ICG/albumin solder. [ICG] ranged from 0.31 mg/mL to 20 mg/mL while PD ranged from 3.2 to 63.7 W/cm^2. Solder color and textural changes were noted. Eighteen rats were subjected to 1.5 cm incisions (N=128) created on the dorsal skin followed by closure with LTS at varying PD and [ICG]. Tensile strength profiles using rat skin were taken immediately and 10 days postoperatively. Histological examination was performed at the time of sacrifice.

Results: Temperature profiles of the ICG/albumin solder did not differ with varying [ICG], but showed statistically significant variability at different laser PD. Using solder color change as a subjective endpoint, average peak solder temperature ranged from 69°C at a PD of 8.0 W/cm^2, 105°C to 120°C at PD 15.9 to 31.8 W/cm^2, and >200°C at PD ≥47.7 W/cm^2. Peak intradermal

temperatures remained below 50°C at all PD. The broadest range of color change in the solder was observed at [ICG] of 2.5 mg/mL. Immediate tensile strength data showed a trend towards greater strength at higher [ICG]. The greatest immediate tensile strength was reached at a PD of ≥31.8 W/cm^2 for all [ICG]. At 10 days an inverse trend existed only between PD (not ICG) and tensile strength, however this was not statistically significant. Histologic analysis showed poorer healing and thermal injury to tissue soldered at a PD ≥ 23.9 W/cm^2.
Conclusions: Based on these findings, optimal laser tissue soldering occurs with an [ICG] of 2.5 mg/ml and a PD of 15.9 W/cm^2.

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COMPARISON OF EPITHELIAL AND DERMAL APPROACHES TO LASER TISSUE SOLDERING FOR SKIN FLAP CLOSURE. DD Suh, IP Schwartz, DA Canning, HM Snyder, SA Zderic, AJ Kirsch. Division of Pediatric Urology, The Children's Hospital of Philadelphia, Philadelphia, Pennsylvania.
Purpose: Prior studies of laser tissue soldering (LTS) of epithelial skin have shown poor wound strength in the short-term, however we hypothesize that greater tensile strength and healing properties will result from directing laser energy to the dermal aspect of the skin. The current study compares wound strength and histology in a rat skin flap model of epithelial and dermally applied LTS.
Methods: Skin flaps (2.5 x 4cm) were raised and bissected on the dorsum of Sprague-Dawley rats. The center line of bissection was closed from a dermal approach by LTS (LTS-D, diode laser 15.9 W/cm^2 + Columbia solder), the upper incision by epithelial LTS (LTS-E), and lower incision by suturing (7-0 vicryl). Wound skin strips (1-2x10mm) were studied immediately (N=14) and at 3 (N=57), 7 (N=31), and 10 (N=28) days postoperatively were subjected to tensiometric analysis. Histologic staining with H & E and Mallory's trichrome methods were used to define wound architecture.
Results: No wound dehiscences were noted in any group. Greater immediate tensile strength was noted in wounds closed by LTS-D (521 ± 61 g/cm^2) versus LTS-E (342 ± 65 g/cm^2), however this difference was not statistically significant ($p = 0.08$). By 3 days, both LTS-D (476 ± 55 g/cm^2) and LTS-E (205 ± 37 g/cm^2) maintained their initial strength, however LTS-D and sutured (436 ± 49 g/cm^2) wounds were stronger ($p < 0.05$) than LTS-E. At 7 and 10 days, LTS-D (2,433 ± 346 g/cm^2 and 3,100 ± 390 g/cm^2) showed superior tensile strength ($p < 0.05$) compared to both LTS-E (1,542 ± 128 g/cm^2 and 2,081 ± 219 g/cm^2) and suturing (1,342 ± 119 g/cm^2 and 1,661 ± 115 g/cm^2). Histologic analysis of LTS-D wounds at both 3 and 7 days showed full thickness tissue apposition, complete epithelialization, presence of solder, and minimal inflammation or thermal injury. In contrast, LTS-E wounds at 3 days displayed lack of epithelialiation secondary to thermal injury and partial thickness tissue apposition; by 7 days epithelialization was complete with moderate scarring, while no solder was seen.
Conclusions: Our results show that skin flap wound healing after dermal LTS is superior to epithelial LTS and emphasizes the importance of site-specificity in the utilization of this operative technique in reconstructive surgery.

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DYE-MEDIATED MONITORING OF TYPE I COLLAGEN DENATURATION
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A feedback system for type I collagen denaturation is important in tissue welding of skin. This study examined the possibility that dye fluorescence can be used as a feedback control signal to probe local temperature or collagen unwinding, responsible for laser tissue welding. Fluorescence anisotropy was studied for dyes bound to collagen which undergoes helix-coil transition. Excitation and emission spectra were also measured by a fluorescence spectrophotometer, as the emission intensity of protein-bound fluorophores often changes with denaturation. Bovine type I collagen, human skin, and bovine tendon were used as model connective tissues. In *in vitro* experiments, bovine type I collagen and various fluorescent dyes (methylene blue, indocyanine green, fluorescein isothiocyanate, eosin B, potamine sky blue, evans blue) were mixed in a cuvette which was heated while fluorescence intensity or anisotropy was monitored at regular temperature intervals. At the transition temperature of bovine type I collagen (~50 C), methylene blue (MB) exhibited a sharp decrease in fluorescence anisotropy, while fluorescein isothiocyanate (FITC) and eosin B showed a sharp 8-fold increase and sharp 2-fold decrease in fluorescence intensity, respectively. In *ex vivo* experiments, excised human skin was heated in presence of various fluorescent dyes (methylene blue, fluorescein isothiocyanate, eosin B, hypericin). Fluorescence intensity was monitored during heating. As expected, FITC showed an increase in fluorescence intensity at the transition temperature of dermal type I collagen (~62.5 C), though not as sharp as in the *in vitro* experiments. In conclusion, we have identified certain fluorescent dyes that can potentially be molecular reporters of local temperature or collagen denaturation. They are MB based on anisotropy measurements and FITC and eosin B based on fluorescence intensity measurements.

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HEALING RESULTS IN MENISCUS AND ARTICULAR CARTILAGE PHOTOCHEMICALLY WELDED WITH 1,8-NAPHTHALIMIDE DYES

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We describe out to two years postoperatively healing results of our study of a procedure for evoking the healing response in meniscal tears and partial thickness defects in articular cartilage by a non-thermal tissue sparing photochemical weld using 1,8-naphthalimide dyes. Welds of incisional flaps in adult sheep meniscus and femoral articular cartilage were made using the dye MBM Gold 012011012 at 12 mM in PBS, 457.9nm Argon ion laser radiation at 800 mW/cm^2, 7.5 minutes (360 J/cm^2) with approximately 1-2 kg/cm^2 externally applied pressure. Gross appreance of tissues in all welded knees was normal; all welds resisted loosening under forceful probing. Hematoxylin and eosin stained sections disclosed close bonding of welded areas, continuing healing response as cellular recruitment, and absence of inflammatory response. Safranin-O stained sections disclosed newly synthesized proteoglycans and collagen. Results of ongoing fluorescent antibody staining for Type I and II collagens will also be presented. These results suggest that healing of the photochemically welded cartilage proceeds by primary tissue regeneration.

UROLOGY

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PHOTOCHEMICAL TISSUE WELDING WITH 2',4',5',7'-TETRA-BROMORHODAMINE 123 BROMIDE

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PURPOSE Covalent bonding of collagen rich tissues has been achieved using1,8 napthalimide dyes. We explore the use of a similar photoalkylating agent, 2',4',5',7'-Tetrabromorhodamine 123 Bromide (TBR) for use in urologic tissue.

METHODS Segments of rabbit ureter were approximated over a plastic stent. 10 µl of TBR (5mg/ml 100% ethanol, peak absorption 510nm) was applied to the anastomosis site. Gentle pressure was applied to insure approximation of the tissue edges. Using a 488nm Argon laser attempted tissue welding was carried out. Power ranged from 50-910mW. Exposure times spanned from 600-1200 seconds. Temperatures recorded by placing a thermocouple probe in the lumen of the stent. Saline irrigation was used when needed to maintain temperatures below 50°C.

RESULTS A total of 20 welds were attempted. Blanching of the TBR was noted in all cases, indicating photochemical transformation. Successful welding was initially noted only when tissue temperatures exceeded 60°C. Cold saline irrigation was added to later attempts to keep temperatures at the weld site less than 50°C. All cases of successful welding were associated with severe dehydration of surrounding tissues.

CONCLUSIONS Effective covalent bonding was not achieved using the photoalkylating agent, tetrabromorhodamine. Possible causes include the molecule's small size and/or the paucity of collagen in urologic tissue. While tissue welding with covalent bonds remains an attractive option, further work is need to achieve this goal.

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PRELIMINARY RESULTS OF A PROSPECTIVE RANDOMIZED CLINCIAL TRIAL OF LASER TISSUE SOLDERING FOR HYPOSPADIAS REPAIR.

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Purpose: The purpose of this study was to evaluate laser tissue soldering using a 808 nm diode laser and wavelength-matched human albumin solder for urethral surgery in children.

Methods: Currently 24 boys, ages 6 months to 5 years (mean 13.5 mo) were randomized to standard suturing (N=11) or "sutureless" laser hypospadias repair (N=13). Laser soldering was performed with a human albumin solder doped with indocyanine green dye (2.5 mg/ml) using a laser power output of 0.5 W, pulse duration of 0.5 sec, and interval of 0.1 sec. Power density was approximately 16 W/cm^2. In the laser group, sutures were used for tissue alignment only. At the time of surgery, neourethral and penile lengths, operative time for urethral repair, and number of sutures/throws were measured. Postoperatively, patients were examined for complications of wound healing or fistula formation.

Results: Mean (± SEM) age, severity of urethral defect, type of repair, and neourethra length were equivalent between the two groups. Operative time was significantly faster for laser soldering in both distal (2.1 ± 0.08 min, $p = 0.01$) and proximal (5.4 ± 0.32 min, $p = 0.001$) hypospadias repair compared to controls (11.4 ± 2.2 min and 30 ± 3.7 min, respectively). The mean number of sutures used in the laser group for distal and proximal repair (3.7 ± 0.33 and 8.3 ± 0.71, respectively) was significantly ($p < 0.01$) less than for controls (8 ± 1.1 and 21 ± 3.1, respectively). The overall complication rate was 15% (2 fistulas) in the laser group and 18% (2 fistulas) in the controls.

Conclusions: These preliminary results indicate that laser tissue soldering for hypospadias repair may be performed in a nearly sutureless fashion and in a more rapid manner than for conventional suturing. The equivalent rate of complications in the laser group at this time indicates that laser soldering deserves further study.

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INTERSTITIAL LASER COAGULATION (ILC) FOR BENIGN PROSTATIC HYPERTROPHY (BPH). FRANK ALEDIA, VAMC, DAYTON, OHIO. To evaluate the efficacy of minimally invasive ILC in the treatment of BPH. Nine patients with BPH were treated with ILC using 830 NM Diode laser between March 5 and August 31, 1997. All patients were either in urinary retention or had AUA symptoms score between 19 and 31, prostatic volume between 18 and 50 cc, uroflow of less than 12 cc/sec, and post-void residual urine between 200 and 300 cc. Prostatic cancer was ruled out by DRE, PSA, and TRUS. All patients were done under local or spinal anesthesia. Laser energy was delivered into the prostatic adenoma through a laser fiber with a diffuser tip. The tissue was heated up to 85°C for 3 minutes at 15 to 20 W with a minimum of two sticks. All patients were followed from 2 weeks to 5 months. Patients were catheter-free in 1 to 3 weeks. All patients had irritative voiding symptoms lasting 4 to 6 weeks. In 2 months, 8 patients were completely asymptomatic. The AUA score dropped to 7 to 16, prostatic volume showed very slight changes, uroflow was between 15 and 21 cc/sec, and residual urine was 50 to 120 cc. One patient decided to keep a Foley indwelling after repeated catheterization. Five patients had cystoscopy 2 to 5 months post-treatment and showed no obstruction with intact urethra. The advantages of ILC are that it may be done under local as an office procedure, shorter operating time, minimal bleeding, and is cost effective. The disadvantages are prolonged catheter time, possible repeat catheterization, and prolonged irritative urinary symptoms. ILC is safe and may be a viable alternative to standard TURP.

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HOLMIUM LASER RESECTION OF THE PROSTATE

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(Presented by Dr. David)

Introduction A number of alternative methods of relieving prostatic outflow obstructions have been developed in recent years. Newer treatments have tried to mimic the success of electrosurgical TURP while avoiding the risks and side effects. In this study we have evaluated the Holmium laser wavelength [2.1µ] which can incise and vaporize tissue with shallow depth of coagulation and fragment bladder calculi.

Methods Transurethral resection of the prostate using the Holmium wavelength through a bare end firing fiber was used. The median, right, and left lateral lobes of the prostate were enucleated. The tissue fragments thus obtained were then removed directly. A cavity results that is identical to an electrosurgical TURP. Bleeding is minimal. Catheters are removed within 24 hours.

Results Prostate sizes have ranged from 15 200 ml (mean 60 ml.) Our initial 60 cases show

improvement in AUA score from 24.8 to 7.1 at 3 mo and 4.5 at 6 mo. Flow rates improved from 9.6cc/sec to 17.6cc/sec at 3 mo. and 20.3cc/sec at 6 mo. Residual volumes were reduced from 302 ml to 44 ml at 3 mo. and 52 ml at 6 mo.

Conclusions Our results show this new technique using the Holmium wavelength gives results analogous to the electrosurgical TURP with minimal complications. The tissue is removed immediately and thus minimal tissue needs to slough as with Nd:YAG. This minimizes the postoperative symptomatic period.

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Pediatric Urologic Applications of the Holmium Laser

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UCLA School of Medicine, Los Angeles

The Holmium laser has become a new weapon in the urologic armementarium. It has become a standard for endoscopic lithotripsy. Its tissue interactions make it an excellent laser for ablation and incisions. We have used the Holmium laser in a number of applications in children and wish to report our work.

Holmium tissue interactions and small flexible fiber delivery systems extend the possible applications into a child's lower and upper urinary tract through 6 and 7 F pediatric cystoscopes.

We describe a number of cases where the Holmium laser extended our endoscopic abilities. These include a case of a recurrent UPJ obstruction in a 4 year old boy after a failed open repair. Laser incision was performed in a retrograde fashion through a flexible ureteroscope making a deep controlled incision. 2 years follow up reveals patency. Another case is a 2 year old boy with urinary retention and azotemia from a benign urethral polyp. The polyp was excised and divided into segments to allow its transurethral removal. We describe cases where we have ablated posterior urethral valves at younger ages than possible with pediatric resectoscopes. We also show incised urethral strictures with excellent results.

The Holmium laser's minimal tissue penetration and ablative characteristics extending our abilities to safely perform endoscopic surgery in the pediatric urinary tract through smaller caliber endoscopes.

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HIGH POWER KTP/532 LASER VAPORIZATION PROSTATECTOMY

R.S. Malek, D.M. Barrett, R.S. Kuntzman, Mayo Clinic, Rochester, MN.

Purpose: Recently, we reported in 2 publications that KTP/532 laser at 38 w vaporized canine prostatic tissue safely and effectively in vivo. It produced a large cavity hemostatically, without scar tissue, and allowed dogs to void without incontinence within 24 hours. At 60 w, KTP/532 laser was equally safe leaving the same 2 mm rim of coagulation, but vaporized the prostate more rapidly. We have since performed high power (60 w) KTP/532 laser vaporization prostatectomy in 7 men with bladder outlet obstruction purely due to BPH.

Methods: With a prototype Laserscope 800 series VHP laser generator, KTP/532 laser energy was delivered continuously via the 70° laterally deflecting Laserscope ADD Stat fiber held 1-2 mm from the tissue through a 22-French Olympus continuous flow cystoscope. The mean prostatic size was 38 ml and mean laser time was 31.2 minutes during which a mean of 33.5 KJ of energy was delivered.

Results: None of the 7 patients suffered any noticeable blood loss or fluid absorption and all were treated as outpatients. Foley catheters were removed in less than 24 hours. The mean peak flow rate increased from 8 ml/sec preoperatively to 21.6 ml/sec 24 hours after surgery (170%, p = 0.0095) and none of the patients had dysuria, hematuria, or incontinence.

Conclusion: Our preliminary experience indicates that KTP/532 laser vaporization prostatectomy is very easy, user-friendly, and effective outpatient technique in producing good symptomatic relief, significant improvement in flow rate, and very quick freedom from Foley catheter drainage. A short video demonstration of the procedure will be presented.

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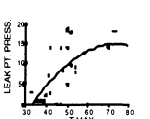
LASER WELDING OF RABBIT URETER USING AN ALBUMIN SOLDER.

Jeff Pugach*, Paul Merguerian*, Michelle Portnoy°, and Lothar Llilge°, *Hospital for Sick Children and °Photonics Research Ontario, Toronto, Ontario, Canada.

PURPOSE Laser welding using a dye-enhanced albumin solder has been shown to have several advantages in urethral surgery. These include: decreased operative time, water-tight seal, minimal foreign body reaction, and minimal thermal injury to adjacent tissues. We present our experience with an improved albumin solder in the creation of rabbit ureteral anastomoses. **METHODS** A 50% albumin solder was created by lyophilizing 25% human albumin, combined with Indocyanin green. Rabbit ureters were harvested and divided into segments. Using 0 proline suture as an luminal stent, the ureteral segments were approximated. Albumin solder (8-10 µl) was placed at the anastomosis site. Using a Diomed 810 nm diode laser at power outputs ranging from 800-1200 mW/cm^2 , the ureters were irradiated for 100-150 seconds. Temperature measurements were recorded using an infra-red video monitor. Initial leak point pressures were measured acutely. A control group of sutured end-to-end anastomoses was tested for initial leak point pressures.



RESULTS Effective tissue welding was achieved consistently when weld site temperatures exceeded 50° C. Adjacent tissue temperatures remained below 35° C. Average leak point pressure exceeded sutured anastomosis when temperatures exceeded 50°C (121 Vs 22.5 cm H_2O, P=0.0001). The technique was easily taught and learned. **CONCLUSIONS** Tissue welding of the rabbit ureter using a dye-enhanced albumin solder is a quick, simple and effective method for creation of a water-tight anastomosis. When temperatures exceed 50° C at the weld site, there is a five fold increase in the average leak point pressure when compared to a standard sutured anastomosis.

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INTERSTITIAL PHOTODYNAMIC THERAPY WITH SnET2 IN THE DOG PROSTATE: TISSUE DRUG UPTAKE AND DOSE RESPONSE STUDIES

Steven H. Selman, Rick Keck, Sandra Kondo and Detlef Albrecht, Medical College of Ohio, Toledo, OH and Miravant, Inc., Santa Barbara, CA

Tin ethyl etiopurpurin (SnET2) uptake in different tissues and dose-response relationship of transperineal interstitial SnET2-PDT were evaluated in two dog studies.

In study 1, fifteen male mongrel dogs (age 2-3 years, weight 25-31 kg) were infused with 1.0 mg/kg SnET2 (Purlytin™, Miravant, Santa Barbara, CA). Drug concentrations were measured in the prostate, urethra, bladder and rectum at 24, 48, 72, 96 and 168 hours post-infusion. In study 2, fifteen male mongrel dogs (age 2-10 years, weight 24-32 kg) were infused with vehicle only (group I), 0.5 mg/kg (II & III) or 1.0 mg/kg SnET2 (IV & V) 24 hours before light administration. After ultrasound-controlled perineal placement of interstitial light diffusers (2 cm length, FXI-402003, Miravant, Santa Barbara, CA), the left and right prostatic lobes of each animal were treated with light at 400mW for 500 sec and 1000 sec, respectively. Hemorrhagic necrosis (II & III) and decrease in prostate volume (IV & V) were measured.
In study 1, the highest drug concentration in the prostate was measured at 96 hours after infusion. The highest selectivity of SnET2 uptake in the prostate vs bladder, vs. rectum and vs. urethra was achieved at 168 hours with a ratio of approximately 5:1.
In study 2, group I animals showed no PDT response. Group II & III animals showed drug/light dose dependent diameter of tissue necrosis. Group IV & V animals showed drug/light dose dependent volume reduction of the prostate. Mild hematuria in 6 animals in groups II-V cleared within 48 hours.
SnET2 drug uptake in the prostate, as well as drug and light dose dependent hemorrhagic necrosis and volume reduction after SnET2-PDT, were documented. Further research is warranted to validate this therapy as a treatment option for BPH and prostate cancer.

VETERINARY MEDICINE

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USE OF THE HOLMIUM LASER FOR PERCUTANEOUS INTERVERTEBRAL DISC ABLATION IN DOGS - UPDATE

Kenneth E. Bartels, George Henry, E.L. Stair, and D. T. Dickey, College of Veterinary Medicine, Oklahoma State University, Stillwater, OK

Purpose: Prophylactic percutaneous laser ablation of canine thoracolumbar intervertebral discs has the advantage of being a minimally invasive procedure that can decrease postoperative complications, shorten recovery time, and reduce medical expenses compared to surgical disc fenestration. The purpose of this study was to determine the efficacy of percutaneous laser ablation of intervertebral discs in more than 130 dogs referred over a five-year period.

Methods: Dogs with recurrent signs of back pain, proprioceptive deficits, or minimal paresis attributable to intervertebral disc disease, or susceptible animals that had undergone a previous decompressive surgery were considered candidates for the procedure. Using fluoroscopic guidance, spinal needles were percutaneously placed through the epaxial musculature and annulus fibrosis into the nucleus pulposus of seven intervertebral discs (T10-11 to L3-4). A 320-um optical fiber connected to a Ho:YAG laser (2100 nm) was inserted into each needle. The laser was activated for 40 seconds at two watts mean power and a 15-Hz pulse repetition rate, resulting in a total energy dose of 80 joules and a fluence of 105 J/cm^2 at the fiber tip. Dogs were immediately recovered from anesthesia and observed for 24 hours. Discharge instructions included restricted activity for two weeks followed by a gradual increase in activity over the next four weeks.

Results: Intervals of assessment ranged from eight months to five years. Three animals have had documented recurrences of disc extrusion that required and responded favorably to surgical intervention. One animal developed discospondylitis at two sites previously ablated, but responded to conservative medical therapy. The remainders of the dogs have not exhibited episodes of "recurrent" disc disease.

Conclusion: Percutaneous holmium laser disc ablation seems to prevent recurrence of protrusion/extrusion of intervertebral disc material in susceptible dogs. Used prophylactically, the minimally invasive procedure has eliminated the need to perform more extensive surgical procedures including surgical fenestration or decompression.

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AN OVERVIEW OF CONDITIONS AFFECTING THE EQUINE UPPER RESPIRATORY TRACT AMENABLE TO NEODYMIUM:YTTRIUM ALUMINUM GARNET LASER TREATMENT, Henry S. Adair, University of Tennessee, Knoxville, TN.

There are numerous conditions of the upper airways that may affect the performance of the horse. Several of these require surgical intervention to effect a cure. The size, shape and complexity of the upper airways make surgery a challenge. The upper airway of the horse is difficult to approach surgically. Many of the recommended procedures also require general anesthesia. The combination of the difficult surgery and general anesthesia, often lead to a prolonged recovery period. The arrival of transendoscopic laser surgery has led to a number of these procedures being performed in the standing individual. Not only is general anesthesia not required, no incision or difficult surgical approach is needed. Because of this there has been an overall decrease in morbidity associated with the procedures and a decreased recovery period. Procedures that will be presented include ventriculectomy, correction of epiglottic entrapment, ablation of ethmoid hematomas, correction of unilateral guttural pouch tympany, granuloma ablation and foreign body removal.

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LASER DOPPLER FLOWMETRY FOR MEASURMENT OF LAMINAR CAPILLARY BLOOD FLOW IN THE HORSE, Henry S. Adair, University of Tennessee, Knoxville, TN

Current methods for in vivo evaluation of digital hemodynamics in the horse include angiography, scintigraphy, Doppler ultrasound, electromagnetic flow and isolated extracorporeal pump perfused digit preparations. These techniques are either non-quantifiable, do not allow for continuous measurement, require destruction of the horse or are invasive. In vitro techniques have also been reported for the evaluation of the effects of vasoactive agents on the digital vessels. In vitro techniques are non-physiologic and have evaluated the vasculature proximal to the coronary band. Many of these techniques require general anesthesia or euthanasia of the animal. Laser Doppler flowmetry is a non-invasive, continuous measure of capillary blood flow. Laser Doppler flowmetry has been used to measure capillary blood flow in many tissues. The principle of this method is to measure the Doppler. Laser Doppler flowmetry records a continuous measurement of the red cell motion in the outer layer of the tissue under study, with little or no influence on physiologic blood flow. This output value constitutes the flux of red cells and is reported as capillary perfusion units. No direct information concerning oxygen, nutrient or waste metabolite exchange in the surrounding tissue is obtained. The relationship between the flowmeter output signal and the flux of red blood cells, is linear. The principles of laser Doppler flowmetry will be discussed and the technique for laminar capillary blood flow measurements will be presented.

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Effects of low-intensity laser light on non-healing wounds in the dog. MD Lucroy, BR Madewell, BF Edwards. School of Veterinary Medicine, University of California-Davis.

Photo-stimulation has been used for a variety of medical therapies, including wound healing. Bio-effects generated from low energy photo-irradiation include stimulation of cell proliferation, collagen synthesis, release of growth factors and DNA synthesis. The action spectrum for the biostimulation of DNA synthesis has peaks in visible blue (404, 454 nm), visible red (620 nm), and near infrared (760, 830) nm wavelengths. Aside from limited *in vitro* and *in vivo* observations, the basic mechanisms underlying laser biostimulation remains controversial because clinical efficacy has not yet been demonstrated unequivocally. This pilot study is designed to examine the effects of low-intensity 630 nm laser light on non-healing wounds in 15 dogs. Dogs with non-healing wounds present for at least 30 days are eligible for study. Light treatment consists of 630 nm light from an argon-pumped tunable dye laser, delivered to the wound surface through a quartz fiber optic fitted with a microlens. The entire wound surface and a 0.5 cm margin around the wound will be treated for 4 consecutive days with an energy density of 5 J/cm^2 and a power density of 20 mW/cm^2, with a resultant treatment time of 250 seconds. Response to laser light will be based on changes to wound surface area, and recorded photographically. At this writing, three dogs have been entered into study. No dogs showed discomfort during treatment. All three dogs had complete closure of the wounds following low intensity laser light treatment. Early results are promising, but inconclusive pending completion of this study; future investigations on the histologic and microbiologic changes following low-intensity laser irradiation are planned.

POSTER SESSION

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LONG-TERM COMPARISON OF THE EFFECTS OF CO2 LASER, SHARP DISSECTION, AND ELECTROCAUTERY ON CUTANEOUS WOUND HEALING

Brooke R. Seckel, Kai Kai Wang, Curtis L. Cetrulo, Jr., Dimitria Chakalis-Haley, Robert R. Hagan, Dept. of Plastic and Reconstructive Surgery, Lahey Hitchcock Medical Center, Burlington, MA

PURPOSE: This study evaluated cutaneous wound healing in rats to compare the long-term tissue response and healing results elicited by incisions made with cold scalpel, unipolar electrocautery and the Ultrapulse CO2 Laser.

METHODS: Three incisions were made on each animal, one by each method. Six incisions of each type were studied at 1,2,3,4,10 days, 3,6 weeks, 3,6 months, and 2 years. A punch biopsy of each incision was taken at the appropriate time point and evaluated with H&E stain for quantitative counts of inflammatory cells, Gomori's stain for reticulum, and Masson's trichrome stain for collagen content. Cell counts were compared between groups at a given time point. Epidermal destruction, collagen content, and cellularity were graded on a four-point scale by a blinded observer. In addition, bursting strength was evaluated at 2,3,4 and 10 days.

RESULTS: Results of histologic grading studies revealed no significant differences between the groups. There was a slight trend toward a decreased inflammatory response and deceased dermal destruction in the group undergoing incision by scalpel, though statistical significance was not attained. Similarly, bursting strengths at all time periods failed to demonstrate any significant differences between the groups.

CONCLUSION: This study suggests that no significant differences in wound healing are exhibited by rats undergoing incisions with scalpel, electrocautery and the Ultrapulse CO2 Laser. Expanding clinical use, including incision, sharp dissection and cosmetic cutaneous resurfacing demand that a more thorough evaluation of the effects of various laser technologies be undertaken. As our understanding of the lasers' effect improves more appropriate clinical application may soon be possible.

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EFFECTS OF WIPING BETWEEN PASSES IN CO_2 LASER SKIN RESURFACING.

EV Ross[b], RD Glatter[a], RA Romero[a], DJ Barnette[b], JM Grevelink[a]. Massachusetts General Hospital[a], Boston, MA and Naval Medical Center[b], San Diego, CA

Using the Ultrapulse CO2 laser, we examined the effects of wiping vs. not wiping on depth of residual thermal damage (RTD), depth of necrosis, and gross wound healing in a farm pig. 3 x 3 cm squares were treated on the animal's flank. The laser was used with the computer pattern generator, pulse energy of 300 mJ, and density of 5. One and three passes were made with and without wiping between passes. Also, one site was treated with one pass, wiped, then treated with two additional passes without wiping. The wounds were followed for 21 days. Biopsies were obtained on postop days 0, 1 and 21. Immediately after irradiation, unwiped sites showed more char than wiped sites. Biopsies from multiple pass sites without wiping showed more "popcorning" and more extensive and variable RTD than wiped sites (250-300 vs 170 μm). One day postop, single pass sites without wiping appeared less desiccated than wiped sites, and biopsies showed less inflammation. Multiple pass unwiped sites were more yellow than wiped sites after one day, and biopsies showed scanty inflammation vs wiped sites, which showed numerous PMN's extending in a band 80-150 μm deep in the dermis. For single pass wounds, despite equivalent immediate RTD, wiping increases the level of wounding, most likely because retained epidermis forms a natural dressing to prevent desiccation. For multiple pass wounds, not wiping increases RTD and depth of injury, resulting in prolonged healing.

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THE LONG TERM HISTOLOGIC EFFECTS OF THE CO2 LASER ON COLLAGEN AND ELASTIN IN TWENTY-TWO PATIENTS

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Division of Plastic Surgery
University of Miami, Florida

The long-term histologic effects of CO2 laser skin resurfacing on collagen and elastin has not been previously demonstrated. Thirty random volunteer patients were studies. Each side of the face was laser resurfaced with a different CO2 laser (collimated, fixed focal point). The upper lip was biopsied preoperatively, six weeks, six months, and one year. Trichrome and Elastin stains were obtained. Eight patients did not

complete the study. At six weeks, neocollagenesis was clearly demonstrated in the Grenz layer. At six months, vast neocollagenesis was observed in the full thickness dermis, and continued to proliferate and organize at one year. Neo-elastagenesis was observed at six weeks and also increased at six months in the full thickness dermis. The elastin became more organized at one year. Neocollagenesis was clerly demonstrated in 18/22 patients. Neo-elastagenesis was observed in 17/22 patients. The CO2 laser effectively stimulates the growth and organization of dermal collagen and elastin.

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LONG TERM FOLLOW UP CLINICAL STUDY OF WOUND HEALING AND ERYTHEMA AFTER SKIN RESURFACING WITH 60 MICROSECOND PULSED CARBON DIOXIDE LASER IN ASIAN SKIN.

Jin Wang Kim , Joung Ok Lee . Dr Kim & Lee's Aesthetic Laser Center. Seoul ,Korea.

Purpose : To report the clinical efficacy of erythema and the durability of the result in Asian on each aesthetic unit.

Material and Methods: Each aesthetic unit 100 laser skin resurfacing with Tru-Pulse Laser(Tissue Technology) were recorded by photographic method immediate postoperation, 1week, 1month, 6 to 16 months, respectively.

Results: Ablation of epidermis and papillary dermis with each laser fluence on aesthetic unit and following results were obtained.

epithelization : mean 8 days.

dedifferentiation and keratinization : mean one and half month.

duration of the erythema : mean 40 days

recurrence of the wrinkle ; no within 16 month

Conclusion : Though the erythrma is essential in wound healing, durability of the result and the erythema period never coincide, but we do know that pretreatment of skin lesions and postoperative care with sunblock and other sunprotective devices is also important in skin type III, VI, V Asian patient.

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EFFECT OF PRETREATMENT ON THE INCIDENCE OF HYPERPIGMENTATION FOLLOWING CUTANEOUS CO_2 LASER RESURFACING

Tina B. West, M.D. and Tina S. Alster, M.D., Washington Institute of Dermatologic Laser Surgery, Washington, D.C.

PURPOSE: Transient hyperpigmentation is the most common complication seen following cutaneous CO_2 laser resurfacing. It is observed more frequently in patients with darker skin tones, but can potentially occur in all types of skin and most commonly appears within the first postoperative month.

METHODS: One-hundred consecutive CO_2 laser resurfacing patients (skin types I-IV) were randomized to receive preoperative treatment with 10% glycolic acid cream (n=25)or 4% hydroquinone and 0.025% tretinoin cream (n=25) for at least 2 weeks. The incidence of post-inflammatory hyperpigmentation in these two groups was compared to its incidence in the 50 control patients who received no pretreatment.

RESULTS: One-third of study patients who underwent cutaneous CO_2 laser resurfacing demonstrated post-inflammatory hyperpigmentation. Patients with darker skin tones had a higher incidence of hyperpigmentation. There was no significant difference in the incidence of post-inflammatory hyperpigmentation between patients who received pretreatment with either glycolic acid or tretinoin/hydroquinone and those who received no pretreatment regimen.

CONCLUSION: Pretreatment of patients with topical glycolic acid or tretinoin/hydroquinone preparations prior to cutaneous CO_2 laser resurfacing does not appear to influence the incidence of post-inflammatory hyperpigmentation following this procedure.

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LONG-TERM EFFECTIVENESS AND SIDE EFFECTS OF LASER RESURFACING. **Woraphong Manuskiatti, Neils Krejci-Papa, Mitchel P. Goldman, Richard E. Fitzpatrick, San Diego, CA**

Purpose: To investigate the long-term effectiveness and side effects of cutaneous laser resurfacing for facial photoaging and wrinkles.

Method: Patients who received CO_2 resurfacing for facial photoaging and wrinkling from August 2, 1994 to August 2, 1996 were followed with clinical evaluation and patient questionnaires. All treatments were performed by two experienced laser surgeons (REF and MPG).

Results: Data available at the time of writing of this abstract [20 patients with average 26-month (12 to 44) post-operative follow-up] demonstrated promising long-term result. According to patient evaluation, 88% of patients had more than 75% satisfactory rating on peri-orbital areas while 66% graded satisfactory rate more than 75% on peri-oral areas. 50% of the patients had no significant discomfort immediately after the procedure while other discomforts included heat sensation (15%), pain (15%), pruritus (10%), and oozing and crusting (10%). 70% of patients reported no long-term problem from the procedure. According to physician's evaluation, there were significant ($p \leq 0.05$) reductions in average wrinkle score on the peri-orbital and peri-oral areas. The incidence of long-term side effects was relatively low including hypopigmentation (10%), hyperpigmentation (5 %) and scar (5%).

Conclusions: Improvement from cutaneous laser resurfacing has persisted over the 26-month post-operative. The presentation will consist of our results on 100 patients.

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RECOVERY TIME AND CLINICAL RESULTS OF TRU-PULSE AND ERBIUM:YAG LASER SKIN RESURFACING

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The Er:YAG and Tru-Pulse lasers for skin resurfacing have been postulated to reduce recovery time by relying on short pulses to reduce the amount of residual thermal injury. Recovery time, duration of erythema and clinical improvement wer

evaluated using an Er:YAG laser (2.94 μm wavelength, 350 μsec pulse, 2 J, 4 mm spot)(n=16) and Tru-Pulse laser (10.6 μm wavelength, 65 μsec pulse, 500 mj, 3 mm square spot)(n=14). Patients were treated with a minimum of 2 passes to the full face and 3-5 passes to the most affected aesthetic unit on each patient. At each follow-up visit, % epithelialization, erythema, and swelling were graded as well as the presence or absence of complications. A moderate amount of tissue shrinkage is observable during the treatment with each laser. Mean time in days to full epithelialization was 6.87 ±0.96 for Er:YAG and 5.93±1.14 for Tru-Pulse lasers. Mean duration of erythema (weeks) was significantly different: Er:YAG 4.56±1.5 weeks, Tru-Pulse 2.79±0.97 (students t-test $p<0.01$). The relatively short duration o erythema provided minimal interference in normal activities for all patients in this series. Swelling was minimal in the Tru-Pulse group and minimal to moderate in the Er:YAG group depending on the number of passes, nonetheless providing no restriction to normal eating, drinking, speaking, or lid opening. There were no infections, or hypertrophic scars. Hyperpigmentation was noted in several patients in each group. Mild hypopigmentation was present in one patient in each group. Contour improvement as measured by optical profilometry and photographs was moderate to excellent. Overall, the period of epithelialization, during which the patient is housebound, is significantly less than previously reported with other lasers. Duration of erythema is drastically reduced. The role of the Tru-Pulse and Er:YAG lasers among other resurfacing modalities remains to be formally established. However, initial evaluation supports safety and efficacy for this type of skin resurfacing, although a different treatment technique with more passes is required.

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COMPARISON BETWEEN THE ERBIUM AND CO_2 ULTRAPULSE LASERS FOR TREATMENT OF ADNEXAL TUMORS.

Jacqueline Calkin, Vera Chotzen, and Suzanne L. Kilmer. Laser & Skin Surgery Center of Northern California, Sacramento, CA.

Adnexal tumors, by virtue of their deep dermal location, have traditionally been very difficult to treat. Violation of the dermis is often associated with scarring. The high energy, short pulsed CO_2 lasers provided benefit for treating these adnexal tumors by enabling localized resurfacing to eradicate or at least minimize these lesions. Although minimal, the thermal damage associated with these high energy CO_2 lasers still made treatment somewhat treacherous. The advent of the erbium laser, with its decreased thermal damage, has made this a potentially safer laser for treating adnexal tumors. To compare the potential benefit of these two lasers, ten patients with adnexal tumors including sebaceous hyperplasia, trichoepitheliomas, and syringomas were treated. The areas to be treated were divided in half and treated with the erbium laser (Derma20, Luxar, Bothwell, WA) (2 to 6 mm spot size, 1.7 joules/pulse) and the CO_2 UltraPulse (Coherent, Palo Alto, CA) (1 to 3 mm spot size, 500 mJ/pulse). Identical wound care was performed which included Vaseline and dilute vinegar soaks. Photographs were taken pre and immediately post-operatively and 1, 4, 12, and 24 weeks following treatment. Treatment discomfort, healing times, pigmentary and textural changes, and percent of resolution were graded by the patient and physician. The study is ongoing and more patients will be presented but early results suggest that patients tolerated the erbium laser better during treatment and for post-operative discomfort. In addition the erbium treated side had less erythema and reepithelialized sooner. The downside of erbium laser treatment may be that the minimal thermal damage might not completely eradicate these lesions. Final outcomes will be presented.

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SUTURE-ASSISTED RESURFACING: CONCOMITANT EXCISION AND CO_2 LASER SKIN RESURFACING IN THE TREATMENT OF ACNE SCARS

Robert H. Gotkin and Deborah S. Sarnoff

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Abstract: The treatment of facial acne scarring is very difficult and has presented a considerable challenge to dermatologists and plastic surgeons over the years. The accepted standard for this treatment has been facial resurfacing with dermabrasion or, more recently, with the new generation of CO_2 lasers. Many acne scars, however, fail to respond to either dermabrasion or CO_2 laser resurfacing, alone, with acceptable cosmetic results. Furthermore, the aesthetic outcome of staged combinations of surgical treatment followed by either dermabrasion or CO_2 laser resurfacing often falls short of both physician and patient expectations. We describe an innovative, new method of treating both atrophic and pitted facial acne scars that is a single stage procedure. Suture-assisted resurfacing (SAR) -- the simultaneous use of direct surgical excision (with primary repair) and CO_2 laser skin resurfacing of various types of acne scars -- yields significant improvement and results in minimal visible scarring. We feel that it is an important and notable advance in the treatment of facial acne scarring.

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Patients' View of Comparison of Erbium: YAG and CO_2 Laser Resurfacing

K Khatri[1], F Sultan[2], R Anderson[1]
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[2]Northeastern University, Boston, MA

Purpose: To assess patients' view of effectiveness and recovery from resurfacing using Er: YAG and CO_2 lasers

Methods: A mail survey of patients who participated in a Er: YAG and CO_2 laser resurfacing comparative study was conducted. Eighteen of 21 patients returned the completed survey

Results: 62% of patients reported over 50% improvement with both lasers when more than 5 passes were used on the Er: YAG treated side and 2 to 3 passes on the CO_2 side. More than 50% felt that wound care was easier on the Er: YAG side. There was no significant difference between the two lasers when asked which laser patients would recommend to their family and friends

Conclusions: Patients felt that both lasers were equally effective in wrinkle removal and that post operative recovery was easier with Er: YAG laser

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Treatment of Spider Veins of the Leg Using a VersaPulse Laser at 532 nanometers.

Thomas O. McMeekin. Genesee Valley Laser Centre.

Yellow light lasers have been used to treat spider veins with pulse widths of .5 to 1.5msec and wavelengths of 585 to 600nm. Spider veins of the legs are known to have larger diameters, deeper depth and may require longer pulse durations and repetitive pulses to achieve satisfactory results. Fifteen patients were treated with the VersaPulse at 532nm, 10msec pulse duration at 3hz with energy densi-

ties of 12 and 16 joules/sq. cm. with a 3mm spot and 2-3 passes on each vessel. The vessel diameters range from .635 to 1.067mm in size. Clearance of spider veins and complications were recorded at 6 weeks, 3 months and 6 months after one treatment. 35mm photos were taken at each follow-up visit. Percent clearance was judged by blinded observers for the pre- and post-operative visits. A modal scale of clearance in quartiles was used for stastistical comparison. The results and complications wlil be discussed.

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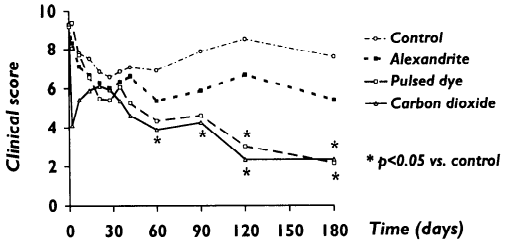
A COMPARATIVE STUDY OF LASER TREATMENT FOR PSORIASIS VULGARIS.

Mariusz J.A. Sapijaszko and Harvey Lui. Division of Dermatology, Vancouver Hospital & Health Sciences Centre, University of British Columbia, Vancouver, British Columbia.

Recently the pulsed dye (PDL) and carbon dioxide (CO_2) lasers have been shown to produce clinical improvement of psoriasis vulgaris. The use of the alexandrite laser (ALEX) for treating psoriasis has not yet been reported. The objective of our study was to compare the response of psoriasis to treatment with the CO_2, PDL, and ALEX lasers. We enrolled 10 adults with plaque-type psoriasis who were not receiving any treatment for psoriasis. One or two plaques of psoriasis were divided into four sections, and treated as follows: Section I was treated with PDL (λ=585 nm, fluence 7 J/cm^2, spot size 7 mm, pulse duration 450 µsec) for up to three separate sessions; section II with a robotized scanner-equipped CO_2 laser (power 6 W, spot size 6 mm, pulse duration 0.2 sec) once; section III with an ALEX laser (λ=755 nm, fluence 25 J/cm^2, spot size 7 mm, pulse duration 5 msec) for up to three separate sessions; section IV served as a non laser treated control. Erythema (E), scaling (S) and elevation (E) of all study sites were each scored on a 0 to 4 scale and totaled. Patients were followed for six months after the first laser treatment.



As compared to control, both the PDL and CO_2 lasers induce long term improvement of psoriasis vulgaris whereas the ALEX laser does not. Only one treatment with CO_2 laser is required to achieve the same clinical improvement as that achieved with multiple PDL treatments. Further studies are necessary to assess the role and mechanisms of action of photothermal lasers for treating psoriasis.

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SIDE EFFECTS FROM HAIR REMOVAL WITH A LONG-PULSE, FREE-RUNNING RUBY LASER

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Excess hair growth constitutes a common cosmetic problem. The condition is currently managed by traditional temporary modalities and by up-coming new laser tools. For up-coming new laser modalities it is important to obtain information about their safety profiles. The purpose of this study was to describe the occurrence of side effects from treatment with a long-pulse, free-running ruby laser, which has been confirmed to be effective in hair removal. Furthermore, we intended to investigate whether the degree of skin pigmentation was important for the development of side effects. Twenty healthy volunteers selected to have varying degrees of skin pigmentation were laser treated once in the hairy pubic region with a free-running, long-pulse ruby laser (694 nm, "Chromos 694 Depilation", SLS Biophile, Wales, UK). The pulse duration was 800 µs and three fluences of 15 - 20 - and 25 J/cm^2 were delivered. Spot diameter was 5 mm. The evaluation of adverse reactions such as hypopigmentation, hyperpigmentation and texture changes was performed blinded on 12 weeks postoperatively and included clinical and photographic evaluations, videomicroscopic documentation, and skin reflectance measurements.

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COMPARISON OF NORMAL MODE RUBY LASER AND EPILIGHT FOR HAIR REMOVAL ON THE FACE

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Two competitive methods for hair removal were compared to evaluate their efficacy and side effects.
Repeated treatments for facial hirsutism were done in monthly intervals on one side with the ruby laser in normal mode (694 nm, double pulses, 0.9 ms pulse width, 1 s delay, 4 mm spotsize, 35 J/cm^2), on the other side with the EpiLight (615 or 645 nm filters, double or triple pulses, 3.1 ms pulse width, 21 ms delay, 38 J/cm^2). Hair counts were done in defined areas in monthly intervals.
The preliminary results show an equal rate of side effects (30%). The ruby laser caused more pain, the EpiLight more swelling and erythema. Half of the patients (53%) stopped the study after 5-10 treatments to continue hair removal only with the EpiLight (better reduction in hair counts, less painful). A 76-100% reduction of black or brown hair was seen in 18% with ruby laser and 40% with EpiLight.
The EpiLight appears to be more efficient in hair removal, though the pulse width of 3 msec might be to short for complete thermolysis (permanent hair removal).

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LONG-PULSED ALEXANDRITE LASER-ASSISTED HAIR REMOVAL: COMPARISONS AT 5, 10, 20 MILLISECOND PULSE DURATIONS

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PURPOSE: To evaluate the safety and efficacy of alexandrite laser-assisted hair removal at varying pulse durations.

METHODS: A prospective controlled study was performed in order to examine alexandrite laser-assisted hair removal in 32 patients with 38 anatomic study locations, including 7 back, 27 leg, and 4 facial sites. Study areas were divided into four quadrants: shaved control square, and three squares shaved and treated separately at 5, 10, and 20 ms pulse durations with an energy fluence of 15 J/cm^2. Pre- and post-treatment hair counts and photographs were compared at 1, 4, 12, and 32 weeks. Side effects and treatment discomfort were recorded.

RESULTS: All laser-treated quadrants resulted in significant hair removal and a delay in hair regrowth for up to three months. No significant differences in efficacy, side effects, or treatment discomfort were detected between laser groups. Transient erythema, post-inflammatory hyperpigmentation and mild burning were the most common side effects, occurring almost exclusively in skin types III and darker. No scarring or permanent textural or pigmentary changes were observed.

CONCLUSIONS: A single laser-assisted hair removal treatment using the long-pulsed alexandrite laser at a 5, 10, or 20 ms pulse duration resulted in a delay in hair regrowth for up to 3 months. No significant differences in hair reduction were noted between laser groups. Side effects were mild, transient, and more commonly observed in darker skin types.

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ONE YEAR FOLLOW UP ON INFLUENCE OF HAIR GROWTH CYCLE ON HAIR FOLLICLE DESTRUCTION BY RUBY LASER PULSES IN MICE

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It has been shown that normal mode ruby laser pulses (694 nm) are effective in selectively destroying brown or black pigmented hair follicles in adult Caucasians. This study investigated how the various stages of the hair follicle growth cycle influence follicle destruction by ruby laser treatment, using a model of predictable synchronous hair growth cycles in the newborn mouse. A range of ruby laser pulse fluences was delivered during different stages of the hair growth cycle, followed by histological and gross observations of the injury and regrowth of hair up to a year. Actively-growing and pigmented anagen stage hair follicles were sensitive to hair removal by normal mode ruby laser exposure, whereas catagen and telogen stage hair follicles were resistant to laser irradiation. Selective thermal injury to follicles was observed histologically, and hair regrowth was fluence-dependent. In animals exposed during anagen, intermediate fluences induced non-scarring alopecia, while high fluences induced scarring alopecia. The findings of this study suggest treatment strategies for optimal laser hair removal.

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CLINICAL ASSESSMENT OF RUBY LASER TREATMENT OF HIRSUTISM

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Preliminary results of our ongoing clinical trial of the ruby laser in normal mode (694nm, 950μs pulse width, 4mm spot) for the treatment of hirsutism were reported last year.

We have recruited 64 patients of skin type I-IV, 59 of which received treatment to facial and 5 to other sites. In each patient one site was treated only once, and a second site four times at monthly intervals. Patients were assessed prior to treatment and after one, two, three, six, nine and twelve months. Pigmented terminal hairs were counted at each visit and side effects were noted. Patients gave an assessment of their response, as well as of pain during and after treatment. A fluence sufficient to produce minimal tissue whitening, or the maximum fluence tolerated by the patient was used (mean 45J/cm^2, range 16-66J/cm^2), which was determined before each treatment. Patients were offered an icepack, but no anaesthesia was used. To date, 48 patients were assessed 6 months following the first treatment, with a percentage reduction to 65% of pre-treatment values in the site treated once and to 24% after four treatments of the same site. Of these, 21 patients were seen 9 months following a single treatment with a mean reduction to 41% of pre-treatment hair counts, which was sustained after 12 months. Nine months following four treatments of the same site, a reduction to 28% of pre-treatment hair counts was found. Sustained adverse effects were not observed. Patients' assessment of their treatment response mirrored these results. The tolerance of treatment was good and tended to improve with consecutive visits, resulting in higher fluences being used (mean 40J/cm^2 at visit 1 to 53J/cm^2 at visit 4). Overall patient satisfaction with treatment was good, with 74% electing to have further treatment after the first 4 months of the study. This study has demonstrated that significant reduction in hair and a high level of patient satisfaction can be achieved with the normal mode ruby laser, and that repeated treatments have greater effects.

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HAIR REMOVAL WITH AN INTENSE PULSED-LIGHT SOURCE

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Long-term hair removal is gaining in popularity around the world. Several laser and laser-like light sources have received U.S. F.D.A. approval for hair removal. These systems will be compared and clinical results with these systems will be presented. The Epilight™ is an intense pulsed-light flashlamp system which has shown great promise in hair removal. Results from the first U.S. clinical trial by the author will be reviewed. This was a one treatment protocol and looked at hair removal over a 12 week period of time. Results, throughout the study, found hair loss up to 60% from one treatment. Results from 6 month and 1 year data will also be described. A multicenter trial, looking at various treatment programs, will also be presented. The Epilight™ is a useful modality for long term hair removal and should be considered a prime modality for this clinical problem.

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Q-SWITCHED AND LONG PULSED RUBY LASER TREATMENT OF NEVOMELANOCYTIC LESIONS.

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Lasers are currently used to treat several types of benign epidermal and dermal pigmented lesions yet are not standardly used to treat nevomelanocytic lesions. Our purpose was to evaluate the effect of normal-mode (NMRL) and Q-switched ruby laser (QSRL) light (694 nm) on nevomelanocytes of benign, atypical, and congenital nevi. Half of each of 31 nevi were treated with either, or both, the Q-switched ruby laser or the normal-mode ruby laser. Four weeks after the last laser treatment, the entire lesion was completely excised. The tissue samples were evaluated histologically by light microscopy and/or digital imaging to determine the effect of laser light on the junctional and dermal nevomelanocytes. Sixteen (52%) of the nevi showed a visible decrease in the pigment in the treatment side at the four week follow-up visit. Fourteen of these nevi had received only one laser treatment. One nevus treated with both lasers had a 100% clinical response. For the 13 nevi that had a decrease in the junctional lentiginous melanocytic hyperplasia component, the number of melanocytes per basement membrane zone distance decreased by 47% percent. For the 12 nevi with a decrease in the dermal component, there was a 38% percent decrease in the depth of the nevomelanocytic nests. In general, the QSRL should more effectively treat epidermal and superficial dermal pigmentation while the NMRL would target pigment in the mid to lower reticular dermis. The longer pulse duration also better targets groups or nests of cells rather than individual organelles or pigment particles. Treating first with the QSRL to diminish the superficial pigment followed by NMRL irradiation may enhance the effect and penetration of the NMRL light. Laser treatment did not induce malignant transformation or an increase in cellular atypia within the three month follow-up period.